

POULTRY WASTE MANAGEMENT

(especially during a drought) not to coat the plants with lagoon liquid. Instead, make several small applications of lagoon liquid, rather than one large one.

Liquid waste is primarily disposed of through land applications. Proper spreading on the land is an environmentally acceptable method of managing waste. However, with increasing environmental concerns, and the need to match closely the fertilizer needs of crops, farmers can no longer afford to simply "spread manure."

The USDA Soil Conservation Service, Cooperative Extension Service, and other agencies offer poultry waste and nutrient management planning assistance. These offices have worksheets to help growers plan liquid waste management, which includes the following tasks:

- ▼ determining the amount and volume of waste generated,
- ▼ calculating land application requirements,
- ▼ sampling and analyzing the nutrient composition in poultry litter, and
- ▼ matching the nutrients available in these products with crop nutrient requirements for land applications.

Detailed information on how to prepare nutrient assessments, conduct soil testing, and calculate application rates, timing, and methods of application are also available from these agencies.

The use of nutrient management planning will help growers make economical and practical use of the organic resources generated on their farms.

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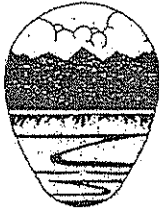
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COMPOSTING WASTE PRODUCTS

Poultry litter or layer manure is most often land applied to pastures and crops for its value as an organic fertilizer. We know from long experience how beneficial this practice can be when soil and manure nutrient testing are integrated with crop nutrient needs to determine the amount and timing of the application. This integration makes it possible to approach land application as a wise use of resources rather than as a disposal method.

Proper storage and treatment of poultry by-products (litter, manure, hatchery waste, and dissolved air flotation [DAF] skimmings) before use are important to minimize compositional changes and decrease odor and handling problems. Depending on the by-product, dry storage, ensiling, or composting may be appropriate treatments. Resource management systems may include incineration and burial as methods of disposal; however, these techniques are not called treatments because they do not usually provide any reusable products.

Composting is an environmentally sound and productive way to treat poultry by-products and mortalities (see also PMM/4). The product of composting is easier to handle, has a smaller volume, and is a more stable product than the raw materials. The nutrient content of the compost will be nearly the same as the starting materials if the composting is performed properly.

While compost can be land applied to decrease the need for nutrients from commercial fertilizers, composted by-products may also be marketed for higher value uses such as turf, nursery, and home and garden uses. It can be added as an amendment to soils for transplanting flowers, trees, and shrubs, or to establish new lawns. Compared to commercial fertilizers, poultry by-product compost will have a

lower nutrient analysis (e.g., 2-2-2) for nitrogen, phosphorus, and potassium. However, there are other benefits to the soil and plant growth associated with the organic matter and micronutrients in compost.

Understanding the Process and Benefits of Composting

Composting is a natural, aerobic, microbiological process in which carbon dioxide, water, and heat are released from organic wastes to produce a stable material. Leaves and other organic debris are subject to this process all the time—that is, the activity of microorganisms transform these materials into a soil-like, humus-rich product called compost.

This natural process can also be used as a resource management technique to transform large quantities of litter, manure, and other poultry by-products into compost. The conditions under which natural composting occurs can be stimulated and controlled so that the materials compost faster and the nutrient value of the compost is maximized.

The composting process is relatively simple:

1. By-products, for example, litter manure, eggshells, hatchery waste, and DAF skimmings, are placed in bins, piles, or elongated piles called windrows. A bulking agent or carbon amendment (e.g., sawdust, wood chips, yard waste, or paper that is rich in carbon but low in other nutrients) is usually necessary to provide the proper ratio of carbon to nitrogen in the mix and improve aeration.
2. Air is added to support and enhance microbial activity. Because composting

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microorganisms are aerobic, that is, oxygen using, sufficient aeration is very important to the efficiency of the process. Sufficient aeration also minimizes the formation of objectionable odors that form under anaerobic (oxygen depleted) conditions. Adequate aeration can be provided by forced air systems, such as blowers or fans; or by turning the compost with a front-end loader or a commercially available compost turner as required.

3. Mechanical agitation or turning of the materials supplies aeration, helps mix the materials, and distributes any added water.
4. Temperatures in the compost must be maintained at levels above approximately 130 °F to kill any pathogens (disease-causing organisms) and promote efficient composting. Temperatures above 150 to 160 °F should be avoided because they reduce microorganisms beneficial to the composting process.
5. Adequate moisture, between 50 and 60 percent, is necessary for optimal microbial activity.

Using Compost

Compost produced from poultry by-products has many potential uses: it can be used directly as a soil amendment for agricultural or horticultural uses, it can be pelletized or granulated for ease of transportation and application, and it can be enhanced with conventional fertilizers to improve its nutrient value. Off-farm uses are limited more by the absence of markets for the products and competition from less costly products than by technical problems. Practically speaking, composting is a preferred method for managing a variety of poultry by-products. Composting is often recommended for use on the farm and at the hatchery.

Possible Drawbacks

Composting, like any management technique, cannot be undertaken lightly, whatever its benefits. It requires a commitment of time and money for equipment, land, storage facilities,

labor, and management. Composting is an inexact process that depends heavily on the quality and characteristics of the materials being composted and the attention given to the composting process.

Although the finished product should have no odor or pest problems, such problems may occur during the composting process. Weather may also affect the process adversely. Compost releases nutrients slowly — as little as 15 percent of the nitrogen in compost may be available during the first year of application. In addition, costs associated with production-scale composting can be significant, and federal and state regulations for stormwater runoff from the composting site must be followed.

Despite these potential drawbacks, composting on the farm is a practical resource management technique. Good management will consider every opportunity to eliminate or reduce the concerns associated with composting while maximizing its benefits. Once it is realized that composting can be more than a "dump it out back and forget it" procedure, the technique can be used and adjusted to meet by-product management needs.

Composting Methods

There are four general methods of composting: passive composting, windrows, aerated piles, and in-vessel composting.

▼ **Passive composting** is the simplest, lowest cost method: it requires little or no management because the materials to be composted are simply stacked into piles and left to decompose naturally over a long time.

Passive composting is not suitable for the large quantities of litter or manure produced on poultry farms. It occurs at comparatively low temperatures and decomposition occurs at a slow rate. Anaerobic conditions resulting from insufficient aeration can result in objectionable odors.

▼ **Windrow composting** occurs in long narrow piles that can vary in height and width depending on the materials and equipment available for turning. For most

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efficient composting, windrows are turned as required depending on temperature and oxygen measurements.

Windrow composting (Fig. 1) is usually well suited to poultry farms. In this method, the windrows are formed from the material to be composted, water, and any bulking agent or carbon amendment. The piles can range from 3 feet high for dense materials to as high as 12 feet for lighter, more porous materials like leaves. If the piles are too large, anaerobic conditions can occur in the middle; if they are too small, insufficient heat will be maintained for pathogen reduction and optimum microbial activity.

The windrows are turned periodically to add oxygen, mix the materials, rebuild porosity (as the mixture settles), release excess heat, and expose all materials equally to the high interior heat that kills pathogens. Turning can be labor and equipment intensive depending on the method used. In the beginning, it may be necessary to turn daily or even several times a day to maintain sufficient oxygen levels; however, turning frequency declines with the windrow's age.

In addition to needing space for the windrows, the producer will also need turning equipment, a source of water, a dial thermometer, and perhaps an oxygen meter. The turning equipment (Fig. 2) can be front-end loaders, manure spreaders with flails and augers to provide good mixing, or specially machines. Often older, unused farm equipment, for example, an old potato plow and a farm tractor, can be used for turning compost.

Temperatures within the windrow are most commonly used to determine when turning is necessary. Low temperatures and odors are signs that more oxygen is needed, while cool or hot spots at intervals along the windrow indicate that the material needs to be mixed. During fly season, all windrows should be turned at least weekly. In the winter, windrows can be combined to conserve heat as they diminish in height. Composting time can vary from weeks to months depending on the

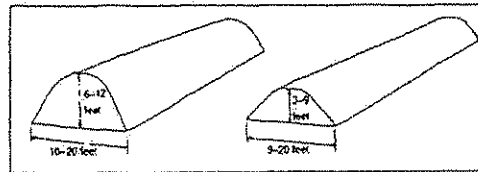


Figure 1.—Typical windrow shapes and dimensions.

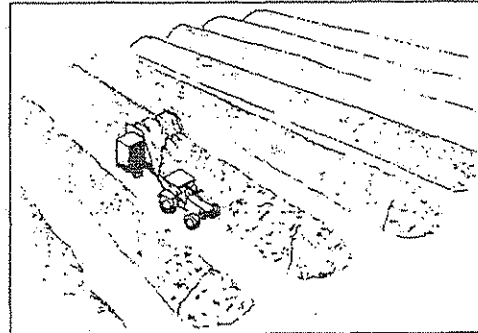


Figure 2.—Windrow composting with an elevating face windrow turner.

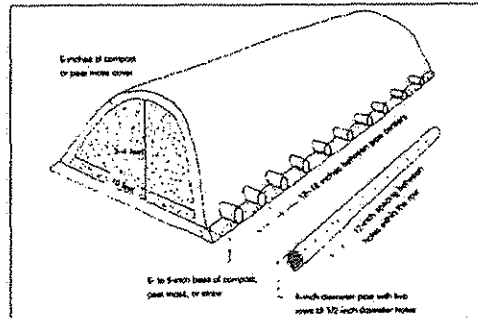


Figure 3.—Passively aerated windrow method for composting manure.

material being composted, the attention given to composting conditions, and the quantity of material composted.

▼ Aerated static composting eliminates the labor of turning the compost by using perforated pipes to introduce air into piles or windrows. Air can be supplied passively, or with blowers to force air into or through the composting material.

Passively aerated windrows (Fig. 3) are a modification of windrow composting that

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eliminates turning. In a commonly used system, the windrow is placed on a base of wood chips, straw, or peat, and perforated aeration pipes are added on top of this base. The material to be composted must be very well mixed, since it is not turned, and the windrow should not be higher than 3 to 4 feet. This method has the advantage of minimizing odors and helping to conserve nitrogen.

Aerated static piles or windrows add blowers to the aeration pipes. This method allows larger piles or windrows and permits more efficient composting than passively aerated static piles. Air can either be drawn into or forced through the composting material. The blowers may be controlled to turn on at set intervals or in response to temperatures in the pile or windrow.

▼ In-vessel composting is similar to aerated methods but the materials to be composted are contained in bins or reactors that allow for control of aeration, temperature, and mixing, in some systems.

In-vessel composting is actually a combination of methods that involve both aeration and turning. The advantages of in-vessel composting include the elimination of weather problems and the containment of odors. In addition, mixing can be optimized, aeration enhanced, and temperature control improved.

The simplest form of in-vessel composting is bin composting, which is readily adaptable to poultry farms. Bins may be plain structures with wood slatted floors and a roof, conventional grain bins, or bulk storage buildings. Other types of in-vessel composters use silos in which the air goes in at the bottom and the exhaust is cap-

tured for odor control at the top; agitated bed systems; and rotating drums. Costs for equipment, operation, and maintenance for a large quantity of materials are high for in-vessel composting.

Factors to consider in choosing a composting method are speed, labor, and costs. Windrows are common on farms; they can use existing equipment, no electricity is required (so they can be remotely located), and they produce a more uniform product. They are, however, also labor intensive and at the mercy of the weather. Adding a paved or compacted clay surface and a simple open-sided building can minimize weather problems and the impact of composting on water quality.

For more information, technical assistance, and possible cost-share programs that may be available to help you begin a composting operation, contact your local conservation district office, the Soil Conservation Service, or the Cooperative Extension Service.

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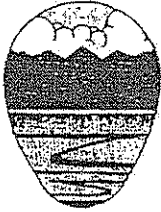
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PUTTING NUTRIENT MANAGEMENT TO WORK

Land application, especially field spreading, is in most cases the best use of poultry wastes. It is cost-effective, disposes of the largest amount of waste closest to the point of production, and is environmentally safe if handled properly. To ensure that waste is not overapplied to the land, the amount and type of nutrients in it must be known and the timing of applications must be adjusted to ensure that growing plants can use the nutrients. The application should also be made evenly, so that all plants have the same access to the nutrients.

What Is a Nutrient Management Plan?

A nutrient management plan is necessary to minimize edge-of-field delivery of nutrients and limit leaching of nutrients from the root zone. Nutrient management plans include developing a nutrient budget for the crop, applying nutrients at the proper time, applying only the types and amounts of nutrients necessary to produce a crop, and considering the environmental hazards of the site.

More specifically, nutrient management plans should apply nutrients at rates necessary to achieve realistic crop yields, improve the timing of nutrient application, and use agronomic crop production technology to increase nutrient use efficiency. At a minimum, nutrient management involves determining the nutrient value of manure by testing, crediting the nitrogen contribution of any legume crop, and testing the soil routinely.

An effective nutrient management plan consists of the following core components:

- ▼ farm and field maps,

- ▼ realistic yield expectations for the crops to be grown,
- ▼ a summary of the nutrient resources available (the results of soil tests and nutrient analyses of manure, sludge, or compost),
- ▼ an evaluation of field limitations based on environmental hazards or concerns (e.g., sinkholes, land near surface water, highly erodible soils),
- ▼ application plans based on the limiting nutrient,
- ▼ plans that include proper timing and application methods (avoid application to frozen soil and during periods of leaching or runoff), and
- ▼ calibration of nutrient application equipment.

The USDA Soil Conservation Service and Cooperative Extension Service offices have prepared tables of the mean average amounts of key nutrients found in different kinds of manure (Table. 1). These tables may be used to estimate the nutrient content of your waste source or stockpile. However, as this resource is produced and used under many different circumstances, it is always best to have samples of your supply tested by a state or private lab.

Preparing Samples

Always prepare your samples from six to 12 representative areas in the poultry house or from at least six different locations in the stockpile. (Samples collected from the stockpile

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Table 1.—Nutrient content of different sources of animal manure.

MANURE TYPE AND HANDLING	INFO. SOURCE	TOTAL N	AMMONIUM-N	PHOSPHORUS P_2O_5	POTASSIUM K_2O
BROILER					
lb/ton					
all types	a	51	13	64	48
fresh (no litter)	b	26	10	17	11
broiler litter	b	72	11	82	46
roaster litter	b	73	12	75	45
breeder litter	b	31	7	54	31
stockpiled litter	b	36	8	80	34
all types	d	59	15	63	40
TURKEY					
lb/ton					
all types	a	61	18	57	41
fresh (no litter)	b	27	8	25	12
brooder litter	b	45	9	52	32
grower litter	b	57	16	72	40
stockpiled litter	b	36	8	72	33
LAYER					
lb/ton					
all types	a	35	14	42	28
fresh (no litter)	b	26	6	22	11
under cage scraped	b	28	14	31	20
highrise stored	b	38	18	56	30
all types	d	39	15	57	30
lb/1000 gallon					
liquid slurry	b	62	42	59	37
anaerobic lagoon sludge	b	26	8	92	13
lb/acre-inch					
anaerobic lagoon liquid	b	179	154	46	266
SWINE					
lb/ton					
fresh	c	12	7	9	9
scraped	c	13	7	12	9
lb/1000 gallon					
liquid slurry	c	31	19	22	17
anaerobic liquid sludge	c	22	6	49	7
all types	d	40	19	37	23
lb/acre-inch					
anaerobic lagoon liquid	c	136	111	53	133
DAIRY					
lb/1000 gallon					
all types	d	28	11	19	25
HORSE					
lb/10 ton					
all types	d	90	6	58	109

a - Data compiled by J. J. Camberlain, Extension Agronomist, 1990-91.

b - Soil Facts-Poultry Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-5.

J. P. Zublena, J. C. Barker, and T. A. Carter.

c - Soil Facts-Swine Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-4.

J. P. Zublena, J. C. Barker, and J. W. Parker.

d - Using Manure to Cut Fertilizer Costs. University of Maryland Cooperative Extension Service Fact Sheet 512. V. Allan Bandel.

should be taken from a depth of about 18 inches; careful handling will ensure that no soil is intermixed in the sample.) Samples should be taken as close as possible to the time of application; however, allow sufficient time to receive test results.

To collect the sample, obtain a quart of waste from six to 12 locations in the house or stock pile and place them in a large, clean bucket. Mix the contents thoroughly; then place about a quart of the mixed sample into a clean plastic bag or bottle. Seal it tightly, but

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allow room for the sample to expand. Keep the sample cool; if it is not mailed to the laboratory on the same day as it was withdrawn from the source, then the entire sample should be refrigerated. The accuracy of the lab test depends on the quality of the samples collected. Contact the lab that will be analyzing your sample for information on collection, handling, and shipping.

For Best Results

Both dry and wet samples should be routinely tested on an "as is" basis for total nitrogen, ammonia-nitrogen, phosphorus, and potassium. The key to successful land applications is to apply the right amount of waste at the right time, using the right method so that the waste's nutrient content is closely correlated with the nutrient needs of the plants and soil. Be aware that some nutrients will accumulate in the soil and reach high levels; apply the product immediately before planting, during a high growth season, and not in bad weather (when the nutrients may be washed away). Incorporate waste in the soil, if possible. For best results, use biennial soil tests in connection with your manure sample and basic calculations.

Land Application Rates and Methods

Whether the poultry waste is taken to nearby farms or spread on your own land, the amount applied, the timing of the applications, and the methods used will affect the outcome. Understanding how the soil and waste interact and calibrating the spreader will help growers apply the right amount at the right time in just the right way.

Manure spread on the surface and not worked into the soil will lose most of its volatile nitrogen compounds, which will be released as ammonium gas to the atmosphere. This release may not represent a pollution potential, but such lost nutrients are not available for plant growth.

Poultry waste spread on frozen or snow-covered soil has a high potential for runoff to surface water. It should not be surface applied to soils near wells, springs, or sinkholes or on slopes adjacent to streams, rivers, or lakes. In fact, some states prohibit this activity. Conser-

vation practices can reduce runoff, nutrient loss, and pollution.

Water pollution potential can be decreased, and the amount of waste nutrients available to plants can be increased, by working poultry waste into the soil either by tillage or by subsurface injection. Subsurface injection of waste only minimally disturbs the soil surface and would be appropriate for reduced till and no-till cropping systems.

Manure or litter must have time to break down before the nutrients in it become available to the crop. Fall applications allow this breakdown to occur, but some of the nitrogen in the manure may be lost through leaching and runoff. Spring applications prevent this nitrogen loss but do not allow enough time for the breakdown of the manure. Incorporation of poultry waste beneath the soil surface in the fall is a way to conserve the nutrients and protect water quality.

Spring and summer applications are recommended based on plant uptake, though it is always important to check for good weather before applications are planned. If litter is applied in bad weather, nutrients may be lost in stormwater runoff. Nutrient-enriched runoff from agriculture could be a leading cause of nonpoint source pollution.

How the poultry waste is applied also affects how quickly the nutrients are incorporated. Generally, incorporation within 12 hours is ideal. The waste can be broadcast over the whole field, followed by incorporation tillage. This method has the advantage of good distribution; because it is visible, the grower can determine the uniformity of the broadcasting. There will, of course, be some odor on the day of the application. Farmers may also want to investigate incorporation, topdress, sidedress, and band application methods.

Spreader Calibrations

Calibration of the spreader machine is also necessary to monitor and control the amount and uniformity of the application. Calibration specifies the combination of settings and travel speed needed to apply nutrients at a desired rate. By knowing a spreader's application rate, a producer can correctly apply the nutrients to

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meet the needs of the plants. Generally, there are two types of nutrient spreaders — solid or semisolid and liquid. Broiler growers handle solid or semisolid nutrients; many egg producers have liquid waste systems.

Solid or semisolid waste is usually handled in box-type or open-tank spreaders, and the application rate is expressed in tons per acre. Nutrient concentrations in pounds per ton can be estimated, or calculated from the lab analysis. The nutrient application rate in pounds per acre must be determined, based on the tons per acre of waste application.

Liquid or slurry waste is usually handled by tank wagons or irrigation systems, and the application rate is expressed in gallons per acre. Nutrient concentrations in pounds per gallon (or pounds per 1,000 gallons) can be estimated or obtained from lab analysis and used with the application rate in gallons per acre to obtain pounds per acre nutrient applied.

The volumetric capacity of spreaders is generally provided by the manufacturer. Caution should be exercised in using manufacturer's data for spreader volume. A more accurate and preferred approach is to calibrate your own equipment.

Assistance is available from the USDA Soil Conservation Service or Cooperative Extension Service offices to calibrate your spreader. Worksheets are available to determine spreader capacity and application rate. Unless the waste has been analyzed for nutrient content and unless the crop soil nutrient needs are known, spreader calibration may have little effect on the application's success.

Once the desired application rate is obtained, record the pertinent information so that you do not have to recalibrate the spreader each time it is used. Spread poultry wastes in a uniform manner. If lush, green growth and not-so-lush growth of plants are observed,

adjustments will need to be made during the next application. Calibration of the nutrient spreader is an important practice that is economically and environmentally useful.

A nutrient management plan should be periodically updated to ensure its effectiveness. Often nutrient management can save a producer money by reducing the amount of fertilizer purchased. This reduction in cost is a result of crediting for nutrients already in the soil and manure. For more information, or for nutrient management planning assistance, contact your local USDA Soil Conservation Service or Cooperative Extension Service office or a nutrient management consultant in your area.

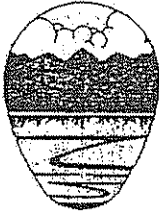
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ECONOMICS OF TRANSPORTING POULTRY WASTES

When land suitable for spreading poultry waste as a fertilizer or soil amendment is not available or not under the control of the poultry grower, new markets for land applications and new ways to use the waste must be found. Poultry waste can be marketed as a fertilizer, soil amendment, growing medium, or beef cattle feed. These options could involve moving the material from the point of production to the point of use.

A Concentrated Industry

Most poultry growers are concentrated within a 25 to 50 mile radius of the hatchery, feed mill, and live bird processing plant. The cost of broiler production increases one cent per pound when the production radius increases over 25 miles. Transportation and labor costs are the reason for the increase, which can cost a broiler production unit an additional \$2 million annually.

However, costs must also be applied to the protection and preservation of water quality. A producer must ask whether it is better to increase the area of the poultry operation to accommodate all waste products or to transport the excess materials to other areas. For example, suppose that a broiler complex that includes pullets and breeders handles about 1 million birds a week. These birds will produce about 65,000 tons of litter annually. At the rate of 4 tons per acre, a total of 16,250 acres will be needed to use this quantity of waste for land applications.

If more than the one company is operating in the area, then even more waste will be produced and more land will be needed. One

method of dealing with these large quantities is to generate markets or disposal areas at a point some distance from the point of production. Growers need to find buyers for their poultry waste. In some instances, custom cleanout operators will broker the waste for the grower.

Because of the bulkiness of the solid or semisolid product, transportation will be the litter buyer's highest cost. An average farm truck can carry 9 to 12 tons. A 30-foot, open trailer used for transporting grains can carry 18 to 24 tons. As load size increases, the cost per ton should decrease. Figure the cost on a round-trip basis, but if you can schedule back-hauls in the empty truck, you can push the costs even lower. Current cost estimates are about \$1 per mile on a round-trip basis for a 20-ton load.

If the grower is paid a per ton price ranging from \$5 to \$10 and the litter has a value of \$22 to \$28 as a fertilizer or \$40 to \$80 as a feed ingredient, the buyer can afford to transport the litter 100 miles for land applications or up to 300 miles for use as a feed.

Other Considerations

A method for loading waste into trucks that have 11-foot sides is needed. Front-end loaders or an elevator that can be loaded with a smaller tractor or skid loader will work. The storage facility must have a smooth hard pad to accommodate the loading process, and the litter must be free of foreign materials such as soil, rocks, broken glass, or other debris. Protect material from stormwater runoff.

Roads and turn-around areas at both ends of the trip must be large enough to accommo-

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date the process, and storage facilities must exist at the delivery depot if land applications or other use will be delayed.

The quality and biosecurity of the waste must be protected. Poultry waste should be transported only from well-managed and disease-free farms. All trucks should be properly cleaned and disinfected, and any leakage from the trucks should be properly drained and diverted from runoff and groundwater. Before transportation to off-farm use, the product should be deep stacked so that the heat in the stack can kill off any harmful microorganisms that might be present.

Transportation of liquid waste is more or less restricted to on-farm or short local hauls because of the type and size of equipment used and transporting time.

Before waste can be readily accepted as a substitute for commercial fertilizer, growers must be confident that this waste product is truly a marketable resource. When properly collected, stored, handled, and used, poultry waste is an effective substitute for fertilizer. It also builds organic matter in the soil and improves soil quality. Thus, it is not a waste, but an economic asset.

Reference

Donald, J.O., and J.P. Blake. 1990. Economics of Transporting Poultry Litter as a Fertilizer. DTP Circular 10/90-007. Alabama Cooperative Extension Service, Auburn University, Auburn, AL.

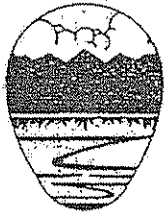
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POULTRY MORTALITY MANAGEMENT

1



AN OVERVIEW OF POULTRY MORTALITY MANAGEMENT

Poultry mortalities — dead birds — are a daily or near daily occurrence. Responsibility for safe and nonwasteful management of the carcasses begins with choosing the best method for their proper disposal. Because dead birds constitute a large portion of the total wastes generated in poultry production, their disposal is a practical problem for growers. In fact, even environmentally safe and economical methods of disposal can be a chore to producers.

Normal mortality for broiler production is 3 to 5 percent over the production cycle or about .01 percent per day. However, the size of flock, the number of birds on hand, and the size and age of the birds will dictate the number and weight of the carcasses that must be disposed of daily. Massive die-offs or catastrophic losses must be handled differently.

Most normal mortalities occur during the first and last two weeks of the growing cycle for broilers and from 10 to 13 weeks of age for layers. Mortality rates in other kinds of poultry operations will be similar to, if not somewhat lower than, the rate for broilers. A single grower, assuming that a typical broiler house holds 20,000 birds weighing 2 to 4 pounds, may have as many as 85 pounds of dead birds to dispose of each day near the end of the growing cycle. A roaster operation may have to dispose of as many as 115 pounds per day, and a turkey operation may dispose of 150 to 200 pounds per day.

Burial in specially designed pits, incineration, and transporting the carcasses off-farm to rendering plants are the three most common means of disposing of dead birds; and recent environmental, economic, and practical con-

cerns have sparked interest in an alternative method: composting. Each of these four methods has best management practice guidelines associated with its use in poultry mortality management.

Burial in pits is not always practical and may not always be permitted. In some places, pits may have adverse effects on water quality, a serious drawback given the intensity and concentration of today's industry. Where permitted, such pits must be properly sized, located, and constructed. The decomposition process in the pit works less well in cold weather, and the pit must be tightly covered for safety and to prevent odors.

Incineration is an acceptable alternative to the use of burial pits. It is environmentally safe, though care must be taken to insure that emissions do not create air quality problems or nuisance odors. Incineration is a more costly method of mortalities disposal; however, incinerator equipment is improving to meet air quality standards.

The Composting Alternative

Composting dead birds has become an acceptable method of disposing of poultry mortalities. Composting is an ancient, natural technique that was practiced with little change throughout the 18th and 19th centuries. In that era, composting methods and speed differed little from the decomposition of organic matter that occurs naturally. The use of composting as a managed method of mortalities disposal is a relatively new process to the poultry grower.

Composting will result in an inoffensive end product; in fact, composting may add value to the waste. Composted dead birds

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make good fertilizer or soil amendment — each carcass is 2 to 9 percent nitrogen, 1 to 4 percent total phosphorus, and 1 to 7 percent total potassium.

Rendering

Rendering may be the most environmentally safe method for disposal of carcasses. It, like composting, adds value to a waste product — in this case by producing feed products, such as feather meal, with or without blood, and other by-products for poultry and other animals.

A major problem with this method of mortality management is to determine how best to transport the carcasses to the plant before decomposition sets in. The grower's concern is to eliminate the possibility that disease or disease-causing organisms might be picked up in the vehicle or at the rendering plant and unintentionally transported back to the farm.

Besides the delivery of fresh carcasses to the renderer, acid preservation and lactic acid fermentation practices can be used on the carcasses. These practices help neutralize pathogens and toxic chemicals and provide for longer holding times on the farm before the carcasses are transported. Refrigeration or freezing is another method to preserve dead birds prior to delivery to the plant.

Before You Decide

Unsanctioned methods, such as feeding the carcasses to hogs or other domestic animals or abandoning them in sinkholes or creeks or in the wild, should not be attempted. Disposing of dead birds in a municipal landfill is also no longer acceptable.

In all cases, dead bird disposal should be recognized as a potential health hazard and in most states, as a regulated activity. Growers must choose the permitted disposal method that best suits them. Standards must be strictly maintained to ensure sanitary conditions and the least possible environmental consequences. Growers should check with their state regulatory agency to be certain that their planned methods of disposal comply with all dead animal disposal regulations. The USDA Soil Conservation Service and Cooperative Extension Service offices can be of assistance.

More detailed discussions of burial pits, incineration, rendering, and composting as methods for managing dead birds can be found in the Poultry Mortality Management (PMM) section of this handbook.

References

- Blake, J.P. 1993. Mortality Management. Presentation. Poultry Waste Management and Water Quality Workshop. Southeastern Poultry and Egg Association, Atlanta, GA.
- Payne, V.W.E., and J.O. Donald. 1991. Poultry Waste Management and Environmental Protection Manual. Circular ANR-580. Alabama Cooperative Extension Service, Auburn, AL.

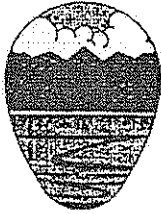
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POULTRY MORTALITY MANAGEMENT

2



BURIAL—A DISPOSAL METHOD FOR DEAD BIRDS

The burial of dead birds in trenches, open pits, and landfills is not an acceptable method of dead bird disposal. In some states, no burial pits whatsoever are permitted — or it is predicted that they will not be permitted in the future. However, in states that do permit this practice, properly constructed disposal pits may provide a safe and economical component of a mortalities management plan. In all cases, the pits must be fabricated.

Fabricated Disposal Pits

A fabricated pit is an open-bottomed, reinforced hole in the ground that has one or more openings at the top through which carcasses are dropped. An airtight cover above the openings prevents odors from escaping. The pit provides an environment for aerobic and anaerobic microorganisms to decompose organic materials. Although disposal pits require minimal labor and supervision, they must be maintained in a sanitary, legal, and socially acceptable manner.

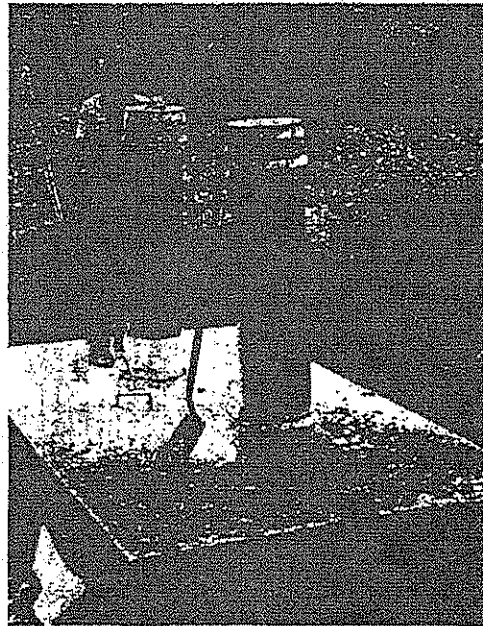
Some prefabricated pits can be purchased from septic tank dealers and delivered to the farm ready for installation. Under no circumstances, however, should the pit be simply a hole in the ground dug with a backhoe and lined with tin. Instead, the fabricated pit should be made of concrete block, poured concrete, or treated timbers. The decomposition process produces very little water inside the pit, but the pit must be covered (with soil and planted to vegetation) to carry water away from the pit and to prevent access to heavy equipment.

The openings — also called drop chutes — are made of plastic (PVC) pipes, which pro-

trude out of the mound at intervals of five feet. The chutes should have tightly fitted but removable covers. The bottom of the pit is earthen with holes at intervals up the sides.

Location

Generally, a disposal pit should be located at least 200 feet from dwellings and the nearest water well, 300 feet from any flowing stream or public body of water, and 25 feet from the poultry house. Before constructing a disposal pit, make certain that the soil composition is



Properly constructed disposal pits are made of concrete block, poured concrete, or treated timbers.

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acceptable. Bedrock (especially limestone) should be avoided. Locate pits in soil where good surface runoff will occur.

To prevent groundwater contamination, the pit's lowest point should be at least five feet above the highest known water table and at least five feet above bedrock to keep contamination from traveling along a rock fissure. To prevent water from seeping into the pit, construction on a slope, floodplain, or low-lying area should be avoided. Sandy soils are not suitable for installing a disposal pit.

Pit Size

The pit itself should be at least six feet deep with reinforced walls. The size of the pit depends on several factors, including the expected mortality rate of the flock, bird size, and environmental conditions. Use the following table to estimate pit size:

TYPE OF PRODUCT	SIZE OF PIT IN CUBIC FEET PER THOUSAND BIRDS
Broilers	50
Turkeys (to 18 weeks)	100
Commercial layers	55

For broiler mortalities, for example, if you have a 5 percent mortality rate in a flock of 20,000 and you raise five flocks per year, your burial pit should contain at least 250 cubic feet of disposal space. That is, it should be about six feet deep, six feet wide, and about seven feet long. Sometimes it can be more convenient to use several smaller pits to prevent overloading. In cooler climates, the pit size should be larger to accommodate a slower rate of decomposition.

Durability and Cost

The life of the pit will depend on its location and whether it is properly sized, constructed, and managed. Because bacterial action is important, the pit must be operated in a way that will protect the bacterial population. High

acidity can slow the decomposition of dead birds. Disposal pits are most efficient during warmer months when bacterial action is greatest. Decomposition is slowed by winter temperatures or by accumulation of water in the pit. Grinding the carcasses or splitting open the dead birds will increase the pit's efficiency and extend its life.

The cost of constructing disposal pits will vary widely depending on the materials used, site conditions, and the size of the pit. The geology — rocky soil, for example — can make digging expensive. As pit size increases, heavier construction is required for walls and tops; thus, higher costs are incurred. For a well-built pit, a useful life of five years is not uncommon, and some producers have reported that pits can be useful for eight to 10 years. Replacement is required when the pit is full.

Operation

After a pit is constructed, producers should check their facilities twice daily for mortalities, which should be transferred immediately to the pit. Covers on the drop chutes should be kept tight at all times to prevent odor and restrict unauthorized access by children, animals, and rodents. Certain insects in a disposal pit are beneficial to the decomposition of the carcasses, but insects should not be allowed to develop into a nuisance. With proper handling the disposal pit costs nothing to maintain except for the labor required to collect the carcasses.

Drawbacks

Burial pits may attract flies and scavengers, and they may create offensive odors. Further, today's farm may have insufficient land space for burying birds, or the capacity of the pits may be limited in wintertime. In many instances, the dead birds do not completely decompose because of the lack of oxygen. Slacked lime may be added to the burial pit to break down the tissue of the dead birds, which will also, in effect, sterilize the remains. If poor soils or a high water table are not considered before pits are dug, groundwater can become contaminated.

Before constructing or installing a prefabricated disposal pit, poultry producers should

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consult with their state's veterinary specialist, other agricultural offices, and environmental or natural resource agencies. These agencies may regulate the use of burial pits, or the state may have disallowed burial pits entirely, so seeking expert guidance will often save time and money. Local USDA Soil Conservation Services or Cooperative Extension Service offices can provide technical assistance to growers who want to use disposal pits as part of their mortality management plans.

References

- Arkansas Soil and Water Conservation Commission and the Water Resources Center. No date. Water Quality and Poultry Disposal Pits. Fact Sheet 2. Arkansas Soil and Water Conservation Commission, Little Rock AR.
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- Wineland, M.J., and T.A. Carter. 1987. Poultry Science and Technology Guide — Proper Disposal of Dead Poultry. PS&T Guide No. 19. North Carolina Agricultural Extension Service, Raleigh.

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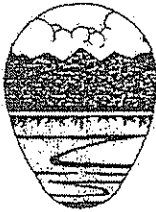
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POULTRY MORTALITY MANAGEMENT

3



INCINERATION — A DISPOSAL METHOD FOR DEAD BIRDS

Incineration, or cremation, is a safe method of carcass disposal and may be an alternative to burial pits. The major advantage of incineration is its security — it is biologically secure, and it will not create water pollution problems. Ash is easy to dispose of and does not attract rodents or pests.

On the other hand, incineration is slow and costly — and likely to become more expensive as fuel costs rise. Incinerators must be properly sited, too, because unpleasant odors may accompany the process. Indeed, an air quality issue for poultry growers who choose this method of mortalities management is the emission of odor and dust (particulates) that may be generated during the process.

Nevertheless, incineration is considered very sanitary when properly applied. Homemade incinerators, that is, 55-gallon barrels or drums containing carcasses that have been drenched in a flammable liquid, are not acceptable and do not meet air quality standards.

Good Incinerator Design

Incinerator design and use are often regulated by states. Producers considering this method of poultry mortality management should consult with their state's environmental and natural resources agencies before incorporating incineration into their mortality management plan. A variety of commercial incinerators are available that will ensure a proper burn and air quality safeguards.

Incinerators should be sturdily built and able to accommodate normal daily mortalities. Those that have automatic controls are most convenient. The unit you purchase should be

able to handle large loads and high temperatures, and the size of the incinerator should also be carefully estimated to avoid overloading the equipment. Other disposal methods should be included in your resource management plan to cover situations in which heavy, unexpected losses occur.

Incinerator Location

Additional considerations include the location and proper operation of the incinerator equipment. Nuisance complaints about incinerators are many; where and how you install and operate your equipment will influence the frequency of these complaints. First, locate the unit downwind of the poultry house, residences, and your neighbors' properties. Second, be sure that the discharge stack is far enough away from trees or wooden structures to avoid fires. Incinerators burn at intensely high temperatures. Locating the incinerator in



A variety of commercial incinerators are available.

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an area convenient to the poultry house will also contribute to better management.

Sheltering the incinerator from inclement weather will extend the life of the unit. For best results, place it on a concrete slab inside a roofed structure.

Incinerator Costs

You will want to consider at least two items to determine the cost of incineration as a disposal method for poultry mortalities:

- ▼ equipment purchase and maintenance, and
- ▼ the rate of burn and fuel costs.

Purchase costs will vary depending on the size and type of the incinerator. Discharge stacks and afterburner devices that recycle the fumes can help control odors and dust, but air pollution is difficult to avoid with incinerators. Expendable parts and grates will need to be replaced periodically — perhaps every two or three years — and the whole system may need replacement (or overhaul) every five to seven years.

The rate of burn will likewise vary depending on the weight, moisture, and fat content of the carcasses and on the loading capacity of the

unit (e.g., incinerators may have to be loaded several times to handle a day's mortalities). Some broiler producers have experienced an average burn rate of about 65 pounds an hour; they estimate that it costs about \$3.50 (1990 estimates) to incinerate 100 pounds of mortalities. If fuel prices increase, so will the cost of each burn.

Incineration is an acceptable and safe method of poultry mortalities management. It does not risk the spread of disease or water pollution; however, it is costly. Not only are direct costs involved in the process, the choice of incineration also means the loss of any nutrient value that the mortalities might have had if composted for land applications or other uses. Growers considering incineration as a method of poultry mortalities management are encouraged to plan this action in connection with their entire resource management system.

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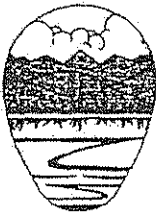
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4



COMPOSTING — A DISPOSAL METHOD FOR DEAD BIRDS

Composting poultry mortalities or dead birds is a practical and sanitary alternative to burial pits and incinerators. It is a fairly odorless and biologically sound practice. Management commitment is the key to the success of composting dead birds.

Composting yields a valuable product: compost, an odorless, spongy humus-like material that has several uses ranging from soil conditioner to horticultural growing medium. However, most states require that composted birds be applied to the grower's own land. Composting also has other advantages:

- ▼ It is not a costly method of mortality disposal.
- ▼ The materials needed for composting — litter, mortalities, straw, and water — are readily available.
- ▼ It increases biosecurity; that is, composting destroys disease-causing organisms and fly larvae.
- ▼ Composting is environmentally sound; properly done, it will not cause odors or water pollution.
- ▼ Once a composting system has been set up, it will not require much labor.
- ▼ Composting systems have been developed and tested to fit both large and small growers' needs.

A Natural Process

Composting is a controlled, natural aerobic process in which heat, bacteria, and fungi change organic wastes into compost. Successful composting requires a specific range of particle sizes, moisture content, carbon-to-nitrogen ratio, and temperature.

▼ **Particle Size.** Particles that are too small will compact to such an extent that air movement into the pile is prevented. Material that is too large allows too much exchange of air, and so prevents the heat from building up properly. A proper mixture of size allows both air exchange and temperature buildup.

▼ **Moisture Content.** The ideal moisture content in the composting pile is 60 percent. Too much moisture can cause the pile to become saturated, which excludes oxygen. The process then becomes anaerobic, a condition that results in offensive odors and attracts flies. Runoff from a composter that is too wet can pollute the soil or water. Too little moisture reduces microbial activity and decreases the rate of composting.

▼ **Carbon-to-Nitrogen Ratio.** Carbon and nitrogen are vital nutrients for the growth and reproduction of bacteria and fungi; therefore, the ratio of carbon to nitrogen (C:N) influences the rate at which the composting process proceeds. Conditions are most ideal for composting when the C:N ratio is between 20:1 and 35:1.

If the carbon ratio is too high, the process slows down because it has insufficient nitrogen. This imbalance can be corrected by

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adding more manure or litter to the compost pile. If the carbon ratio is too low, the bacteria and fungi cannot use all of the available nitrogen, and the excess nitrogen is converted to ammonia, resulting in unpleasant odors. This problem is fixed by adding more straw or sawdust.

▼ **Temperature.** The best indicator of proper biological activity in the compost is temperature. Use a probe-type 36-inch stainless steel thermometer, 0 to 250 °F, with a pointed tip to monitor temperatures within the compost pile. Optimum temperature range is 130 to 150 °F. When the temperature decreases, the general problem is that not enough oxygen is available for the bacteria and fungi. Oxygen can be replenished by turning or aerating the pile. Temperatures will rise as the composting process repeats itself.

The cycle of composting, turning, composting can be repeated as long as there is organic material available to compost and the proper moisture content and C:N ratio are present. When temperatures reach the optimum range for three days, harmful microorganisms (pathogens) and fly larvae will be destroyed. Daily recording of the temperatures in the piles is important because it will indicate whether the bacteria and fungi are working properly.

Composter Design and Operation

Composting poultry mortalities can be done in or outside the poultry house, but it should always be done in an environmentally safe and healthy manner, under a roof, and protected from rain. Dead bird composters are generally classified as single-stage or two-stage structures. The small, single-stage composter was developed to dispose of small birds, to operate in normal or lower than normal mortality events, and to serve small farms without front-end loaders. The operation is simple, yet effective, and requires only a shovel or pitchfork and a thermometer.

To make an in-house composter, use four screen-and-lumber panels (about 40 by 36 inches) to make a single square bin (Fig. 1). Each bin has a capacity of up to 30 pounds of dead birds per day or a total capacity of 600

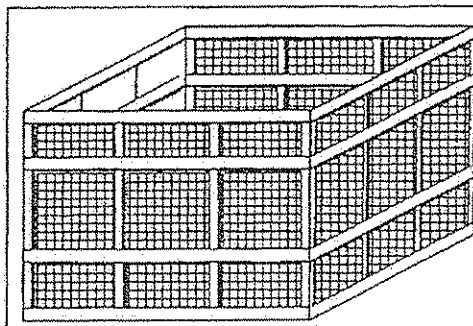


Figure 1.—Typical in-house composter.

pounds. Four to six such bins will handle the dead birds from a 20,000-bird broiler house at a cost of about \$500. Position assembled bins at a location convenient for gathering the dead birds and for easy access for unloading between flocks.

The process for composting in a single-stage composter begins with the procedures previously described. The recipe or start-up materials are 200 pounds of litter, one-third bale of straw, and 15 gallons of water. Add these ingredients to a bin in the following order: 6 inches of loose straw, 65 pounds dry litter, and 5 gallons of water. Repeat the layering process three times until all start-up ingredients have been used. Insert thermometer; when the material reaches 140 to 150 °F, the composter is ready to begin processing dead birds.

Form a V-shaped 18-inch deep trough in the center of the bin. Add straw, litter, dead birds, water, and litter, and cover or cap with start-up ingredients. Avoid placing dead birds closer than 6 inches to the walls. Mixing and aeration take place when the bin is prepared for the next load of dead birds (Fig. 2). Record the temperature at a depth of 8 to 20 inches in the center of the pile daily. Repeat this procedure until the bin is filled. Compost may be used in place of new materials to restart.

An outside single-stage composter can be any size. However, an area 4 feet square and a 36-by-48-inch bin is a workable size. Place the bins on a concrete pad with a roof to protect the compost from excessive moisture, anaerobic conditions, and pests. The management of, and recipe for, outside composters are the

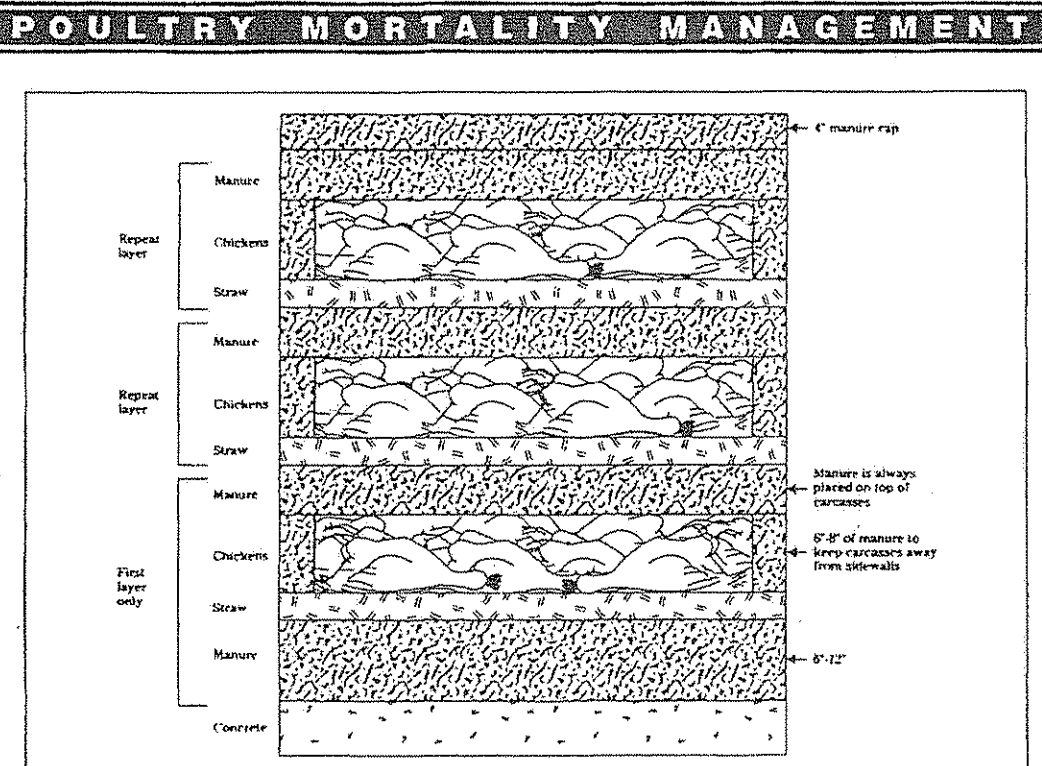


Figure 4.—Recommended layering for dead bird composting.

Use the same layering sequence (dead birds, litter, and straw) after loading mortalities that only partially complete a layer. If dead birds are carelessly loaded — stacked one on another or placed against the sidewalls of the structure — they will putrefy. Once the compost pile is complete, or full, "cap it off" with a 6-inch layer of dry litter, manure, straw, or similar material to reduce the potential for attracting flies and to provide a more pleasing appearance. This same recipe can be used for composting caged layers, broilers, turkeys, breeders, or other types of poultry.

Mixing, aerating, and moving the composting mass with a front-end loader or shovel will uniformly distribute the ingredients, add oxygen to the pile, and reinvigorate the composting process. Temperatures will rise after each mixing until all the organic material is decomposed. After the pile is capped, wait 11 to 14 days before turning the mixture. However, if the temperature falls below 120 °F or rises above 180 °F, the compost pile should be aerated or mixed immediately.

Elements of a Composting System

The decision to use a composting system for poultry mortality management means that the grower is committed to managing the compost properly and seeking help as needed. The composter should be adequately sized to process the normal mortalities that occur in an operation. To determine the proper size of the composting unit, contact the USDA Soil Conservation Service or a Cooperative Extension office for assistance. A few general principles apply.

▼ **Location and Access.** The composter should not be located near any residence. Offensive odors are not usually generated in the composting process; still, the handling of dead birds, manure, and litter on a daily basis may not be aesthetically pleasing. The site should be well drained and accessible; farm equipment is usually needed to carry dead birds and compost ingredients to the composter and to remove the finished compost.

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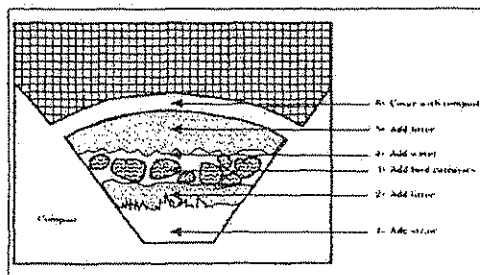


Figure 2.—Loading an in-house composter.

same as for in-house composters, but adjustments can be made to meet individual situations. The time and hand labor required to manage an outside composter must be carefully considered before installation. The cost of an outside single-stage composter varies according to its size, from \$500 to \$1,500.

Two-stage Composters

A two-stage composter is larger and more expensive than the single-stage composter, but it will accommodate more dead birds. A two-stage composter is also less labor intensive because it relies on mechanized equipment. However, it must be compatible with the man-

agement capabilities of the producer. The composting process is done in primary and secondary bins. The following requirements describe the design and lay-out of a two-stage composter.

- ▼ The size of the composter is 1 cubic foot of primary bin and 1 cubic foot of secondary bin per pound of daily mortality.
- ▼ The height of bins should not exceed 5 feet. Heights greater than 5 feet increase compaction and the potential for overheating.
- ▼ The width of the bins is usually selected to accommodate the loading and unloading of equipment. A width of 8 feet is normal, but the bins could be wider.
- ▼ Most bins are typically 5 or 6 feet deep, although deeper bins can be used. Longer bins are more difficult to enter and exit and take more time to work.
- ▼ Several smaller primary bins work more efficiently than a few large bins. Secondary bins can be larger, but they must have the same capacity as the primary bins (see Fig. 3).

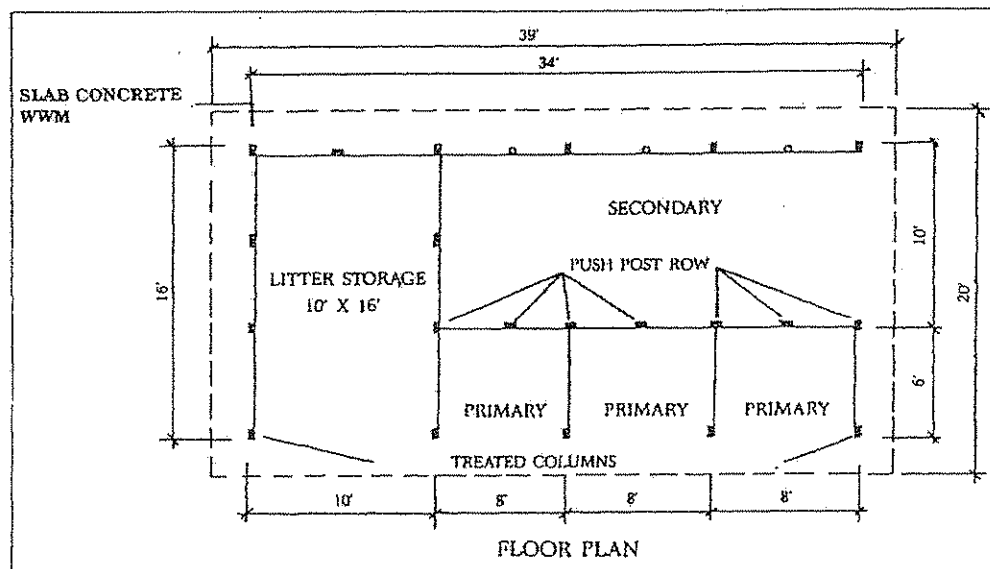


Figure 3.—Typical two-stage composter floor plan (not to scale).

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- ▼ It is desirable to have extra primary bins in which to store litter and straw. If high mortalities occur, these bins could be used for composting.
- ▼ Ceiling height of the composters should be high enough to accommodate a front-end loader extended upward.
- ▼ Concrete flooring should be extended beyond the bins sufficiently to allow a tractor or other equipment to work entirely on a concrete surface. Dirt or gravel will rut, dig out, and reduce traction.
- ▼ Roof overhang must extend sufficiently to prevent blowing rain from reaching the compost. Side curtains are another option to protect the compost from blowing rain. Maintain dry conditions within the composting structures.
- ▼ A composter that has a litter storage facility can greatly enhance the management of dead birds, building cleanout, and litter spreading operations.
- ▼ The composting facility should be supplied with fire protection equipment in case the compost self-ignites.
- ▼ The composting facility should be equipped with water and electrical services. Water is required for the compost recipe, equipment cleanup, and for the washdown of personnel. Electrical outlets are required for lights and power tools or appliances.

Costs of composters depend on many factors — size, configuration (e.g., work areas, ingredients, and finished compost storage), and utilities. Some composting structures have been built for as little as \$500; others, for as much as \$50,000. No specific plan or layout for composters works best in all cases. Many different designs will perform adequately, but management capabilities determine the success of the composting process. Standard plans and management information for poultry mortality composters are available through local USDA Soil Conservation Service or Cooperative Extension Service offices.

Financial aid or cost-share funding may be available to help pay for the design and construction of composting facilities. Check with your local conservation district, USDA Soil Conservation Service, or Cooperative Extension Service offices to learn more about these programs.

Composting Recipe

For composting poultry mortalities in a two-stage composter, a prescribed mixture of ingredients is used called a "recipe." The recipe calls for one part dead birds, one part manure and litter, two-to-three parts straw or other carbon source, and zero-to-a-half part water (Table 1). Recipes for a single-stage composter differ slightly.

Table 1.—Typical recipe for composting dead birds with litter, straw and water as ingredients.

INGREDIENTS	PARTS BY WEIGHT
Dead Birds	1.0
Litter or cake	1.5
Straw	0.1
Water*	0.2

*Water as an ingredient may not be necessary. Too much water may result in anaerobic condition.

Proper layering of the recipe will ensure appropriate heat for composting the mortalities in about 14 days. To begin, place 6 to 12 inches of litter or manure, followed by a 6-inch layer of loose straw to provide aeration, followed by a layer of dead birds. Depending on the moisture content of the manure or cake, water may or may not be added. Repeat this layering process until the pile or bin is full (see Fig. 4).

Leave 6 to 8 inches of space between the edges of the dead bird layer and the wooden wall of the composter. This space allows air movement around the pile and keeps carcasses nearer to the center of the pile, where the heat is highest. Do not stack dead birds on top of each other. They may be adjacent to one another, even touching, but they must be arranged in a single layer. Spread litter or manure and straw as evenly as possible.

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▼ **Foundations.** An impervious, weight-bearing foundation or floor, preferably of concrete, should be provided under primary and secondary composting vessels or bins. Experience has shown that after frequent loading and unloading activities, dirt or gravel tends to become rutted and pot-holed. A good foundation ensures all-weather operation, helps secure against rodent and animal activity, and minimizes the potential for pollution of surrounding areas.

▼ **Building Materials and Design.** Pressure-treated lumber or other rot-resistant materials are necessary. A roofed composter ensures year-round, all-weather operation, helps control stormwater runoff, and preserves composting ingredients at the desired moisture content. Adequate roof height is also needed for clearance when using a front-end loader. The amount of rain that is blown into the composter can be minimized by the addition of partial sidewalls or curtains and guttering along the roof.

Thus, the key requirements for a mortality composter are good management; a properly sized, properly located facility; easy access; and a well-constructed, roofed structure. Following these regulations will result in a mor-

talities management system that is nonpolluting and capable of producing a valuable by-product.

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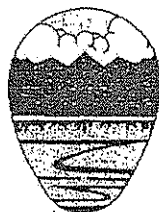
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RENDERING — A DISPOSAL METHOD FOR DEAD BIRDS

Rendering — the process of separating animal fats, usually by cooking, to produce usable ingredients such as lard, protein, feed products, or nutrients — is an ancient waste management process. It is also an excellent way to recycle dead birds. We are now able to reclaim or recycle almost 100 percent of inedible raw poultry material through rendering techniques.

Until recently, the animal protein in meat and bone meal residues was considered a waste of the rendering process; it was usually discarded, though it could sometimes be used as a fertilizer. Now rendering plants pick up or receive about 91 million pounds of waste annually to supply 85 percent of all fats and oils used in the United States. They also export 35 percent of the fats and oils used worldwide. Rendering operations provide a vital link between the feed industry and the poultry grower and help us control odor and prevent air and water pollution.

Rendering has not always been widely practiced as a poultry mortality management technique because

- ▼ dead birds may carry disease-causing organisms;
- ▼ suitable facilities for rendering have not always been available; and
- ▼ it can be difficult to keep the carcasses suitable for rendering.

Thus, dangers associated with the routine pick up and delivery of the carcasses to the rendering plant have been perceived as a threat to avian health and the environment.

Rendering's great advantage as a management technique is that it removes mortalities from the farm and relieves the grower of environmental concerns related to other methods of disposal. It may also provide some economic return. Therefore, as concerns for nutrient losses and water quality increase, producers and buyers of poultry products are experimenting with new techniques for delivering poultry mortalities to rendering plants as part of their mortalities management planning.

A major disadvantage of rendering as it is usually perceived is that disease may be carried back to the poultry farm by the vehicles or containers used to convey the dead birds to the rendering plant. Appropriate management and handling techniques can alleviate this difficulty.

Holding Methods

Raw or fresh poultry mortalities that are destined for a rendering plant must be held in a leak-proof, fly-proof container, and they must be delivered to, or be picked up by, a rendering company within 24 hours of death. All mortalities must be held in a form that retards decomposition until they are collected.

Freezing or Refrigeration, A New Holding Technique

Some producers are experimenting with a technique that combines on-the-farm freezing or refrigeration and the rendering process to determine whether freezing can be an effective way for growers to hold dead birds until they can be rendered. Large custom-built or ordinary commercial freezer boxes are being used to preserve dead birds until they can be picked

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up and delivered to the rendering plant. Custom-built boxes or units are usually free standing with self-contained refrigeration units designed to operate at temperatures between 10 and 20 °F.

Ideally, these freezer units will have no environmental or health impacts. The smaller ones are designed to allow the immediate removal of the carcasses from the growers; the larger ones, to hold the birds frozen until the box is full or otherwise scheduled for delivery to the plant.

Large domestic freezers will hold about 250 to 300 pounds of dead birds. Specifically designed boxes can handle 1,600 to 2,000 pounds of dead birds and are easily loaded through various door arrangements. They must also be sealed against weather and air leakage. The grower can load the freezer each day — once is a minimum. Putting the birds in the freezer in a single layer helps ensure that all the carcasses are properly refrigerated or frozen.

Fresh unfrozen carcasses are added to the box as the top layer. The temperatures are set to allow the product to be completely frozen within 24 hours. Check the temperature gauge at each loading. Overloading may prevent the total freezing of the carcasses.

The boxes can be emptied at the end of each growing cycle or as needed. The rendering plant can send a truck to the farm, or the grower may deliver the unit to the plant. Boxes or containers are picked up (using a forklift or front-end loader) and emptied. The freezer boxes open from the top, bottom, or sides for easy access and are then resealed. The refrigeration unit never leaves the farm, only the container holding the dead birds is removed or emptied. Freezer units are expected to last roughly 10 years. They operate on energy efficient circuit boxes with an operating cost of about \$1.50 per day.

So far, the cost of freezing as a collection method is related to the cost of energy; its potential for generating income is not yet known. The product is processed at a rendering plant. Although some companies have already made an investment in these units, other growers should be able to recoup the costs of freezer

boxes and product transportation. Transfer of pathogens or harmful microorganisms between farms has not been found to be a problem with this method of collection. Additional research is needed to fully explore this management option and any pathogenic problems that may be perceived in it; however, its proponents stress its usefulness as a way to reduce or eliminate potential pollution and improve conditions on the farm.

Fermentation

Fermentation procedures have been explored to determine whether they can contribute to a biologically secure and environmentally safe method of holding poultry carcasses until their nutrient components can be recovered in a form suitable for reprocessing and refeeding.

Fermentation is, in fact, a way to safely dispose of poultry mortalities, but it also keeps them on-site until the end of the growing cycle or until sufficient volume is attained for delivery to a rendering plant. Fermentation mixes the mortalities and a fermentable carbohydrate, such as sugar, whey, ground corn, or molasses.

The fermentation process produces organic acids that lower the pH of the mixture. The acidity of fresh tissue is near neutral (pH equals 6.3 to 6.5), while the acidity of the silage is 4.0 to 4.5. Thus, the activity of anaerobic bacteria (*Lactobacillus*, which are found naturally in poultry) converts the sugars into lactic acid and lowers the pH to less than 5.0, thus inactivating the pathogenic microorganisms in the carcasses and preserving the organic materials.

In the experiments presently underway, it has not been necessary to use any bacterial inoculant in the mixture. The fermented product is incubated anaerobically in airtight containers where it can be safely stored for several months — that is, until the amount of the product suffices to warrant the cost of transportation to the rendering plant.

Acid Preservation

Preserving foodstuff by acidification has been a widespread practice in agriculture. This method of preserving dead birds is the same as the fermentation process except that propionic,

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phosphoric, or sulfuric acid is added to the poultry carcasses, which are kept in an airtight, plastic container. Sulfuric acid may be preferred because it (1) retards spoilage, (2) excellently preserves the carcass, and (3) is relatively low in cost.

Carcasses can be punctured with a blunt metal rod rather than placed through a grinder. Punctured carcasses can be separated from the acid solution without the accumulation of sludge in the holding container.

The product resulting from lactic acid fermentation and acid preservation reduces the transportation costs associated with rendering by 90 percent. What is more important, however, is that these processes eliminate the potential for transmitting pathogenic organisms into the rendered products or environment. Accurate costs of fermentation and preservation are limited because most of the work has been through research. It is estimated, however, that costs will range from three to four cents per pound of dead birds.

In an expanding poultry industry, the production of manure and mortalities will only in-

crease. Producers should contact the renderers in their area to determine which holding and transportation methods are acceptable, and they must increase their search for safe, cost-effective disposal and reuse methods. Every possible safe method should be explored until each grower determines the method most compatible with his or her situation and management abilities. Rendering, like composting, adds value to the end product.

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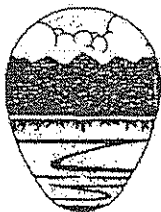
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SITE SELECTION FOR THE POULTRY FARMSTEAD

Site selection and general farmstead planning are important elements in subsequent profitability and ease of animal waste management handling. Each site is, of course, unique, but some general environmental and safety considerations apply to all sites. Besides the visual impact, the first considerations are air quality (dust and odor control); the movement and quality of the water (drainage and supply), and availability of sufficient land for handling waste production. Site selection is also an appropriate beginning for establishing a good neighbor policy.

A good location will help you minimize potential problems with odor, rats, flies, beetles, and mice. Locating the poultry house conveniently near the farm residence is useful; but the location should also be attractive, or the house should be shielded (not visible) from the road, especially if it is near a property line. Building a vegetative windbreak or fence will not only help the operation's appearance, it will also reduce dust and odors that might create a nuisance, or the perception of a nuisance, among your neighbors. If the house is sited

within an adequate windshed, many potential air quality problems can be avoided with little or no adverse effect on the community (see Fig. 1).

Soil drainage (both surface and subsurface) is likewise an important consideration. A site on relatively high ground with adequate drainage can help prevent flooding, road wash outs, wet litter, and disease. Good drainage coupled with an appropriate use of gutters and grading around the outside of the building will direct runoff away from the production facility and family home. Soil drainage helps ensure access to the facility at all times on all-weather roads. It also helps secure a safe drinking water supply.

Subsurface drainage is also important to prevent excessive nutrients or other possible contaminants from entering the groundwater. In the manure storage area, a barrier between the manure and the ground is needed, such as a plastic tarp under the gravel or concrete base of the structure. Within the house itself, the removal of cake and wet litter should be planned; waterers should be inspected for leaks; and stirring, air drying, and ventilation should be part of standard operating procedures. Foundation drains or footing drains can also be added to remove any subsurface water that might otherwise enter the house.

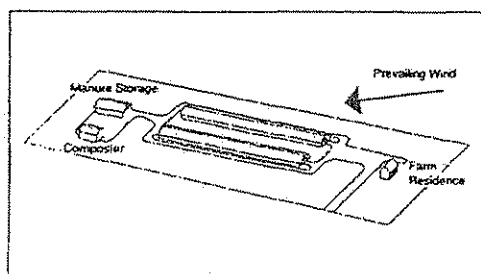


Figure 1.—Siting of a typical broiler operation.

Manure Storage Sites

Manure storage sheds, stacks, or windrows should be convenient to the poultry house, but distant enough to reduce disease transmissions between flocks or houses. A distance of 100 feet is reasonable. Storage structures are usually 40 feet wide with a 14-to-16-foot clearance.

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The length varies depending on the amount of manure to be stored. Many of these structures are three-sided — a rectangle with one end open. The interior wall should be strong enough to withstand the weight of piled manure and the force of front-end loaders.

The site for a stack or windrow should be properly prepared before manure is laid down. If the storage time exceeds one month, a pad must be available, and the stack or windrow should be covered to reduce flies and odor problems. Manure stored on the bare earth must be completely removed to avoid creating an area in which high salinity and nitrate-nitrogen are a potential for groundwater contamination.

Dead Poultry Disposal

In the past, poultry mortalities were simply buried on site, but this disposal method is no longer feasible and is, in some places, illegal. Composting is one of several alternative methods that use this resource economically; it also helps protect water quality. For composting to work effectively, however, an appropriate structure is necessary. This structure can be conveniently attached to the manure storage facility. Refer to the appropriate fact sheets on manure storage and poultry mortality management for additional material on these topics.

The Farm*A*Syst Assessment Program

A new program that is helping to prevent water pollution in rural America is called Farm*A*Syst, the Farmstead Assessment System. It is a voluntary, farmstead or rural resident pollution risk assessment, designed to help rural residents become knowledgeable

about water pollution risks and to help them develop an action plan to reduce the risks identified by the system. It may also be a useful tool for site selection and general farmstead planning.

The Farm*A*Syst program addresses nutrient contamination, water well design and location, waste and fertilizer storage, septic systems, dead bird disposal, pesticide and petroleum storage, household and farmstead hazardous waste and waste disposal, and microorganism contamination of well water. Growers can learn more about this program and how they can participate in it by contacting the National Farm*A*Syst Staff, B142 Steenbock, 550 Babcock Drive, University of Wisconsin, Madison, WI 53706 (phone 608/262-0024); or the USDA Soil Conservation Service or Cooperative Extension Service offices. Farm*A*Syst is jointly funded by the USDA Soil Conservation and Cooperative Extension Services, and the U.S. Environmental Protection Agency.

Conclusion

Proper siting and design of a poultry facility is important to the economy and success of the whole operation. It prevents problems before they arise, thus saving the grower money, time and worry, and best of all, it protects the environment and community from serious problems or distressing nuisances.

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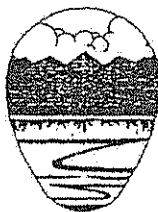
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AIR QUALITY AND ITS MANAGEMENT

The Clean Air Act of 1970 provided for uniform air quality standards and control of emissions from existing facilities. It also prohibited the construction of new facilities that violate or interfere with federal or state regulations for air quality standards. Although many of the private citizen complaints and civil suits brought against livestock and poultry operators are because of odor problems, many of the states' air quality requirements have been established as a direct result of federal legislation. The odor (and sometimes dust) problems derived from poultry operations are associated with improper or mismanaged burial pits, emissions from incinerators, and land applications of poultry waste.

The Clean Air Act Amendment of 1990 (Pub. Law 101-549) also contains provisions of importance to producers of agricultural products. Because its goals are to reduce emissions that cause acid rain and to protect stratospheric ozone, ammonia volatilization from animal and other agricultural operations will most likely come under increased scrutiny and possible control. Some states are starting to request atmospheric ammonia test results on air samples taken at the property lines of animal operations.

Methane emissions from "rice and livestock production" and from "all forms of waste management . . . including storage, treatment, and disposal" are mentioned in the 1990 law as being of concern with regard to ozone depletion. These sources and others, both nationally and internationally, are to be evaluated by EPA jointly with the secretaries of Agriculture and Energy, and control options will be developed that can be used to stop or reduce growth of methane concentrations in the atmosphere.

Poultry Production Facilities and Air Quality

Poultry production facilities can be the source of gases, aerosols, vapors, and dust that can, individually or in combination, create air quality problems. These problems include

- ▼ nuisance odors,
- ▼ health problems for poultry in confined housing,
- ▼ deadly gases that can affect poultry and humans, and
- ▼ corrosion.

A variety of gases are generated during the decomposition of poultry wastes. Under aerobic conditions, carbon dioxide is the principal gas produced; under anaerobic conditions, the primary gases are methane and carbon dioxide. About 60 to 70 percent of the gas generated in an anaerobic lagoon or pit is methane and about 30 percent is carbon dioxide. Trace amounts of more than 40 other compounds have been identified in the air exposed to degrading animal waste, including mercaptans (the odor generated by skunks and the smell introduced in natural gas are in the mercaptan family), aromatics, sulfides, and various esters, carbonyls, and amines.

Methane, Carbon Dioxide, Ammonia, and Hydrogen Sulfide

The gases of most interest and concern in poultry nutrient management are methane (CH_4), carbon dioxide (CO_2), ammonia (NH_3), and hydrogen sulfide (H_2S). The following paragraphs summarize the most significant characteristics of these gases.

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▼ **Methane.** Methane, a flammable gas, is a possible source of energy on the farm. Because methane is also explosive, extreme care is required when attempting to generate and capture this gas for on-farm use.

▼ **Carbon Dioxide.** Carbon dioxide can be an asphyxiant when it displaces normal air in a confined facility. Because CO₂ is heavier than air, it remains in a tank or other well-sealed structure, gradually displacing the lighter gases. With high-density housing, gas and particulate levels may increase, and control becomes more difficult. Carbon dioxide increases substantially with the larger number of poultry producing CO₂ as compared with earlier low-density housing. Continued monitoring of temperature, air removal rate, and manure moisture content is required to maintain proper carbon dioxide concentrations.

▼ **Ammonia.** Ammonia is primarily an irritant and has been known to create health problems in animal confinement buildings. Irritation of the eyes and respiratory tract are common problems from prolonged exposure to this gas. It is also associated with soil acidification processes.

Ammonia concentration in broiler houses has increased in the past few years. The primary reason is that ventilation rates are reduced to conserve heat in the winter months. Research also shows that dust particles serve as an ammonia transport mechanism, so over-ventilation to the outside may lead to odors near the house and overly dry litter inside the house.

Ammonia concentration increases with increasing pH, temperature, and litter moisture content. It is desirable to maintain litter moisture in a production house below 30 percent for ammonia control. Studies indicate that ammonia increases bird susceptibility to Newcas-

tle disease and decreases feed intake and egg production.

▼ **Hydrogen Sulfide.** Hydrogen sulfide is deadly. Humans and farm animals have been killed by this gas after falling into or entering a manure tank or a building in which a manure tank was being agitated. Although only small amounts of hydrogen sulfide are produced as compared to other major gases, this gas is heavier than air and becomes more concentrated over time.

Hydrogen sulfide has the distinct odor of rotten eggs. Hydrogen sulfide deadens the olfactory nerves (the sense of smell); therefore, if the smell of rotten eggs appears to have disappeared, this does not indicate that the area is not still contaminated with this highly poisonous gas. Forced-air ventilation or an exhaust system helps prevent gas poisoning. Otherwise, evacuate the area until the gas can be removed.

Where to Go for Help

Information on achieving air quality standards and managing the air quality problems of poultry production facilities is available from the U.S. Department of Agriculture, U.S. Environmental Protection Agency, and the Department of Energy. Poultry associations and state water quality agencies can also help.

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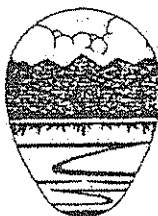
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PREVENTING FIRES IN MANURE/LITTER STORAGE STRUCTURES

Hundreds of poultry manure/litter storage structures have been built as a component of a total waste management program on the poultry farmstead. Storage facilities help prevent the possibility of water pollution and provide flexibility in the timing of land applications. They also protect this resource from the weather and wildlife so that it can be used as a cattle feed.

Manure piles will generate heat, however, and care should be taken to prevent fires in the storage facility. Spontaneous combustion in a litter stack is possible, probably as a result of the buildup of combustible methane or the storage of wet and dry litter. Fires may also occur if the manure is stacked too close to wooden walls that may ignite when the temperature in the litter reaches the wood's flash point. The exact causes of litter storage fires are difficult to know, but good management principles will help protect the litter.

Methane Production

Anaerobic bacteria generate about 50 to 65 percent methane, about 30 percent carbon dioxide, and a smaller percentage of other gases. Therefore, if the moisture content of stored litter is more than 40 percent in a stack with little or no oxygen, then conditions are right for anaerobic bacteria to grow and methane to result. Unvented landfills have the same problem. Methane's specific gravity is less than air, however. If the stack has adequate pore spaces (or the landfill has ventilation pipes), the methane will escape into the atmosphere.

High moisture levels in stored litter help create the potential for fires, as does layering the manure (putting new litter on top of old litter). Compacting the litter will trap heat in the pile, and failure to provide an adequate ratio of surface area to volume can also create problems.

Tips for Fire Prevention

The following guidelines will help prevent fires in storage facilities:

- ▼ Keep the litter dry and do not stack it too near the open end of the building (methane is flammable in air).
- ▼ Do not compact moist cake or mix it with dry litter; and do not stack cake or dry litter higher than 5 feet or store it against the wood.
- ▼ Do not compact the dry litter, since compacting creates anaerobic conditions and prevents the natural venting of methane.
- ▼ Do not cover moist litter but allow the open litter to vent naturally.
- ▼ Monitor the resources in your storage facility regularly, and remove any materials that have temperatures greater than 180 °F. If the temperatures exceed 190 °F, notify the fire department and prepare to move the material. Emptying the storage area will bring the litter out into the air, so precautions must be taken against a fire occurring at this time.

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It is a good idea not to store expensive equipment in the litter storage facility.

If you are storing dry litter for later use as a cattle feed, cover it with polyethylene. This technique will suppress the temperature buildup and reduce the production of bound nitrogen, a form of protein that cattle are unable to digest.

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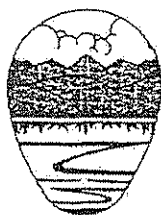
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TREATMENT LAGOONS AND PONDS

Manure in shallow pits (from caged layers) can be flushed out once a day or scraped out dry every one to three days. Flushed manure can then be transferred to storage by gravity or with a pump. Semisolid or liquid manure can be stored in below or above ground ground storage tanks, steel storage tanks, or earthen basins. Thus, lagoons are a type of earthen basin used for waste storage; however, they can also be used as manure treatment systems for converting the organic matter in animal wastes into more stable products. Lagoons have even been used as digesters to convert large masses of waste into gases, liquids, or sludge. Aerobic and anaerobic lagoons work with bacteria to decompose the dissolved solids in animal waste.

Lagoons became a somewhat popular component of waste management systems during the 1970s when the interest shifted from simply using waste for fertilizer in land applications to treating the waste to produce a more convenient waste management system overall.

Anaerobic bacteria in animal waste (i.e., bacteria that live in animal intestines) cannot work in the presence of oxygen. Aerobic bacteria, on the other hand, must have oxygen; therefore, anaerobic lagoons are deep and airless; aerobic lagoons are spread over a large surface area, take in oxygen from the air, and support algae.

The advantages of lagoons are that they are easy to manage, convenient, and cost-efficient. Storage and land application can be handled more opportunely if the grower has a lagoon, and labor costs and operating costs are slight

after the initial investment. In general, anaerobic lagoons do not require much space, and they provide storage and disposal flexibility.

Other factors, however, must also be considered. Lagoons are a source of odors and nitrogen losses and may require frequent sludge removal if they are undersized. Groundwater protection may be difficult to secure, and if mechanical aeration is used, energy costs must be included in the accounting. Proper management is essential for lagoon maintenance and operation.

Aerobic Lagoons

The design, shape, size, capacity, location, and construction of the lagoon depends on its type. Aerobic lagoons require so much surface area (to maintain sufficient dissolved oxygen) that they are an impractical solution to most waste management problems. They may require 25 times more surface area and 10 times more volume than an anaerobic lagoon. Nevertheless, some growers may consider using an aerated lagoon — despite its expense — if they are operating in an area highly sensitive to odor.

Some of the sizing difficulty can be solved by using mechanical aeration — by pumping air into the lagoon — but the energy costs for continuous aeration can be high. Aerobic lagoons will have better odor control, and the bacterial digestion they provide will be more complete than the digestion in anaerobic lagoons.

Lagoon design and loading specifications should be carefully followed and monitored to increase the effectiveness of the treatment. No more than 44 pounds of biological oxygen demand (BOD) effluent should be added to the

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lagoon per day per acre. The lagoon should have sufficient depth so that light will penetrate the 3 or 4 feet of water. Effluents from the lagoon should be land applied to avoid long-term ponding and to make economical use of the nutrients that remain in them.

Anaerobic Lagoons

Anaerobic treatment lagoons are earthen basins or ponds containing diluted manure that will be broken down or decomposed without free oxygen. In the process, the organic components or BOD in the manure will be liquified or degraded naturally. Anaerobic lagoons must be properly designed, sized, and managed to be an acceptable animal waste treatment facility.

Liquid volume rather than area determines the size of anaerobic lagoons. The lagoon should accommodate the design treatment liquid capacity and the amount of wastewater to be treated; it should also have additional storage room for sludge buildup, temporary storage room for rain and wastewater inputs, extra surface storage for a 25-year, 24-hour storm event, and at least an additional foot of freeboard to prevent overflows.

The design criteria for anaerobic lagoons are based on the amount of volatile solids to be loaded each day. The range is from 2.8 to 4.8 pounds of volatile solids per day per 1,000 cubic feet of lagoon liquid. The amount of rain that would collect in a 24-hour storm so intense that its probability of happening is once in 25 years requires at least 5 to 9 inches of surface storage.

To protect the groundwater supply, lagoons should not be situated on permeable soils that will not seal, on shallow soils, or over fractured rock. Nor should mortalities be disposed of in lagoons; in fact, screening the wastes before they enter the lagoon helps ensure complete digestion and the quality of the wastewaters for land applications. If the site's topography indicates a potential for groundwater contamination, then any earthen basin should be lined with clay, concrete, or a synthetic liner.

New lagoons should be filled one-half full with wastewater before waste loading begins.

Planning start up in warm weather and seeding the bottom with sludge from another lagoon helps to establish the bacterial population. Because bacterial activities increase in high temperatures, lagoons, in general, work best in warm climates. Manure should be added to anaerobic lagoons daily, and irrigation (drawdown) should begin when the liquid reaches normal wastewater maximum capacity. The liquid should not be pumped below the design level treatment, however, because the proper volume must be available for optimum bacterial digestion.

Drawdown (that is, the lagoon liquid) can be used for land applications guided by regular nutrient management planning and sampling of the lagoon liquids and soils to ensure safe and effective applications. When sludge accumulation diminishes the lagoon's treatment capacity, it, too, can be land applied under strictly monitored conditions.

Secondary lagoons are often needed for storage from the primary lagoon. Using a secondary lagoon for irrigation also bypasses some of the solids picked up in the primary lagoon. The size of secondary lagoons is not critical.

Information and technical assistance and some cost-share programs are available for producers who determine that a lagoon system should be part of their resource management system. The USDA Soil Conservation and Cooperative Extension Service offices can provide additional assistance.

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TREATMENT LAGOONS AND PONDS 3

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